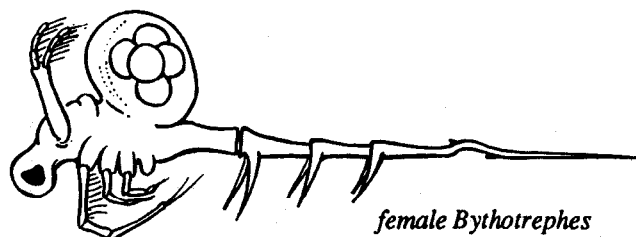


Spiny Tailed *Bythotrephes* In the Great Lakes

A fact sheet from the Michigan Sea Grant College Program



The Great Lakes have experienced invasions by dozens of exotic species during the last century. Some of the introduced species were the result of human planning and intensive management, as was the case with the coho and chinook salmon. Other additions were unintentional. The alewife and the sea lamprey, which entered the upper Great Lakes through the Welland Canal, are two examples of accidental additions.

Although most planned introductions have been fish species, accidental introductions have involved vertebrates and invertebrates alike. The ruffe and zebra mussel are two examples of exotic species that have recently captured public attention. Both invaded the Great Lakes from their native habitats in Europe. The mussel has become a nuisance by clogging the intakes of water pipes and outboard boat engines. The ruffe possesses protective, bony fins which discourage bigger fish from eating it. Thus it may survive better than native species of small fish, to the eventual detriment of the game fish that rely on the small fish for food.

Invaders like the zebra mussel and the ruffe receive much attention because they can be common in shallow water near shore and because they are large enough to be easily seen. Less well-known, but smaller, invaders are no less important within the complex ecological communities of the Great Lakes. For example, during the 1980s the zooplankton *Bythotrephes cederstroemi*, (sometimes called the "spiny water flea," although it is not an insect) entered the waters of the Great Lakes from a European source. Although its average length is scarcely more than one centimeter (0.4 inch), *Bythotrephes* can have as profound an effect on an ecosystem as a larger invader.

Unique Body Structure

Bythotrephes (bith-o-TREH-fee-z) is easily recognized by its unique body shape. The tail spine is its distinguishing feature and separates it from all other free-swimming lake invertebrate animals, or zooplankton. The spine often comprises over 70 percent of the animal's total length, and contains from one to four pairs of thorn-like barbs.

Juveniles are born with just one pair, so these barbs can be used to determine the age of the animal.

The head consists primarily of a single, large eye filled with black pigment. Also present are a pair of mandibles, or jaws. *Bythotrephes* uses these sickle-shaped mandibles to pierce and shred its prey. The animals possess four pairs of legs, the first pair being much longer than the others. These first legs are used for catching prey, whereas the other pairs of limbs are designed for grasping prey while they are being consumed.

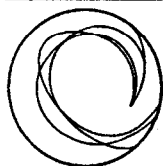
Just behind the head is a pair of swimming antennae, which propel the animals through the water. *Bythotrephes* are good swimmers, moving several times their body length in a second. The ability to swim, as opposed to merely drifting with the current, helps *Bythotrephes* to encounter prey and to move between shallow and deeper lake waters.

Bythotrephes belongs to the class Crustacea, a group of animals such as crabs and shrimp that possesses a hard exoskeleton (outer shell). Like all other Crustacea, its exoskeleton is molted in order to grow. *Bythotrephes* is unique for it sheds only the exoskeleton that covers its body, retaining the exoskeleton that covers the tail spine. The animal is never without its long, stout spine, a fact which suggests to biologists that the tail serves a vital protective function.

Unusual Reproductive Cycle

Bythotrephes is able to have a remarkable influence on the biological communities of the Great Lakes, largely because of its rapid reproduction. Reproductive females carry their offspring on their backs in a balloon-like brood pouch, which can be filled either with developing embryos or resting eggs. Most of the time, female *Bythotrephes* exhibit a rapid and unusual method of reproduction known as parthenogenesis, or asexual reproduction. By this method, females produce from one to ten eggs that are able to develop into new females without mating or fertilization. The new females are genetic replicas of the mother.

The generation time of this parthenogenic life cycle (embryo to adult female) varies with water temperature, because, as with all Crustacea, rates of metabolism rise and fall with temperature. During the summer when the surface water of the lake is warm, *Bythotrephes* can produce a new generation without fertilization (parthenogenesis) in less than two weeks. Since males are not needed for parthenogenesis, they are rarely found when food is plentiful, or when environmental conditions favor rapid population growth.



The Michigan Sea Grant College Program is a cooperative program of Michigan State University and the University of Michigan designed to support greater knowledge and wise use of the Great Lakes and ocean resources.
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In Bythotrephes, sex of offspring is not determined genetically, but rather by environmental factors. So, when food becomes limited or when the lake cools in the fall, males begin to appear. Declining environmental quality can be sensed by adult females, who respond by producing male rather than female offspring. These males are able to mate with surviving females, producing resting eggs. The resting eggs are first carried as orange-brown spheres in the female brood pouch. They are later released and fall to the lake bottom where they can survive the cold winter. In spring or early summer, these eggs hatch into juvenile females that begin parthenogenic reproduction again.

Resting eggs can remain dormant for long periods of time, and they offer an explanation for the arrival of Bythotrephes in North America. The animal is native to northern Europe, including the British Isles, Scandinavia, and the Soviet Union. The first living specimen in the New World was found in Lake Huron in December 1984. The most likely mode of transport was in fresh water or mud brought to the Great Lakes from Europe in the ballast water of merchant ships. By 1985, Bythotrephes had spread to Lakes Erie and Ontario. It had invaded Lake Michigan by 1986 and Lake Superior by 1987.

Disrupting the Balance

Biologists have documented the arrival of Bythotrephes into Lake Michigan, and they have studied the subsequent effects of this new predator on other species in the lake. As a consequence of these scientific investigations, much has been learned about the complex biological community of Lake Michigan, and about the interactions and special dependencies of various predators and prey, particularly fish and plankton.

Bythotrephes eat smaller herbivorous Crustacea, including the common zooplankton, Daphnia. Daphnia, however, is also an important food item for small, juvenile fish such as the bloater chub. Bythotrephes thus competes directly with young fish for food. Because of their unique reproductive pattern, Bythotrephes can reproduce many times faster than the fish. Their rapid population growth enables Bythotrephes to monopolize the food supply at times, to the eventual detriment of the fish.

Although Bythotrephes can fall prey to fish, its spine seems to frustrate most small fish, which tend to experience great difficulty swallowing the animal. In Lake Michigan, Bythotrephes can rarely be found in stomachs of fish less than 5 centimeter (2 inches) in length, although fish of that size avidly consume Daphnia when that food

item is available. There are indications that the growth rates and survival of these young fish may be adversely affected by the presence of Bythotrephes in the ecosystem, owing to competition for food. In general, the more abundant Bythotrephes becomes, the less food will remain available for juvenile fish.

Behavior Patterns Reduce Predation

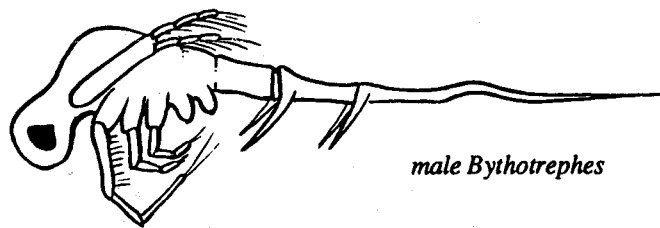
In European lakes, populations of Bythotrephes are often suppressed as the result of predation by larger fish. The large black eye and full brood pouch makes adult females quite visible to fish, and fish prefer them over smaller species of zooplankton. Faced with possible predation by fish, Bythotrephes has been found to adopt a behavior called diel (daily) vertical migration. Adult females move deeper in the water during daylight hours, where less light penetrates and visibility to fish is reduced. At night, they rise closer to the surface, where there is abundant food and the warmer water increases metabolism and growth.

In the offshore waters of Lake Michigan, Bythotrephes is found mainly from 10 to 20 meters (33 to 66 feet) deep during the day, while at night the majority of the population is in water from 0 to 10 meters (0 to 33 feet) deep.

Are They Here to Stay?

Scientific study suggests that Bythotrephes has become a permanent member of the Great Lakes ecosystem, and has carved out a niche for itself at some cost to lake fisheries. The quick success of the animal in colonizing all of the Great Lakes raises the possibility that it may soon invade smaller, inland lakes in the Great Lakes basin. Studies are continuing to identify effects of this and other introduced species on the food webs and the fish communities of the lakes. You can help these studies by reporting any sightings of Bythotrephes or other alien species in inland lakes to your Department of Natural Resources, or the Sea Grant program in your state.

Written by Michigan Sea Grant researchers Carla E. Caceres and John T. Lehman



male Bythotrephes

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